

Study Group 4

ELECTRONIC FUNDAMENTALS



Service Practices 7:

HOW TO READ METERS

Service Practices 8:

HOW TO UNDERSTAND
METER READINGS



RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA
New York,

N. Y.

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 7

HOW TO READ METERS

- 7-1. Care of Meters
- 7-2. Meter Scales
- 7-3. Voltage Measurement
- 7-4. Current Measurement
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Service Practices 7

INTRODUCTION

Radio and TV servicemen use many kinds of test equipment. A small repair shop may have several hundred dollars invested in meters and other test equipment, while a large, well-equipped shop may contain two or three thousand dollars worth of such equipment. Much of the equipment used in modern radio and TV shops is bought to help the serviceman locate radio and television receiver troubles faster and more easily. When a piece of test equipment is used often enough, its cost is usually justified by time saving and greater efficiency in trouble shooting.

Yet, if a man understands the theory behind electrical radio and television circuits, troubles may be located without investing in a lot of expensive equipment.

There is one piece of equipment, however, which is absolutely necessary — a piece of equipment that no successful serviceman can do without. It is a meter to measure current, voltage, and resistance — in other words, a multimeter. The meter that you have been assembling in Experiment Lessons 3, 5, and 7 is such a meter.

It is a little early in the course to discuss the theory behind the multimeter. As soon as you are prepared with the basic knowledge necessary to understand meter theory, it will be the subject of a theory lesson. However, it is possible to use such a meter even without knowing exactly why it does what it does.

7-1. CARE OF METERS

Of all the equipment that radio and TV servicemen use, few instruments are as liable as a meter to be damaged because of a moment's carelessness. So, a service-

man must learn never to use his meter without thinking of what he's doing, to take care of his meter, and to protect it from damage. Few servicemen can afford to own more than one multimeter at a time. For that reason, if your meter is damaged you may be prevented from handling a large portion of the service calls that may come your way while the meter is being repaired. Time and money lost through a moment's inattention or carelessness cannot be replaced. Therefore, it pays to learn how to use and care for your meter. Then your meter will always be in working condition when you need it.

The basic meter movement is usually as

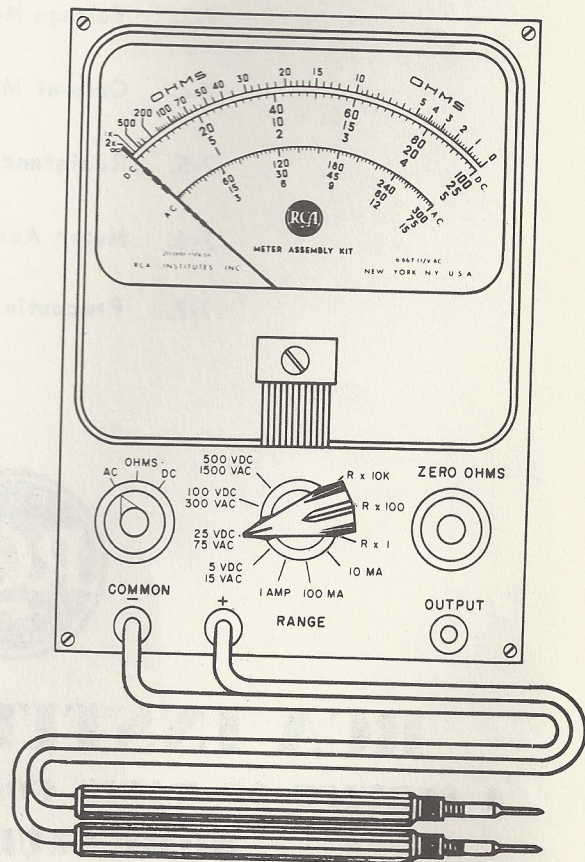


Fig. 7-1

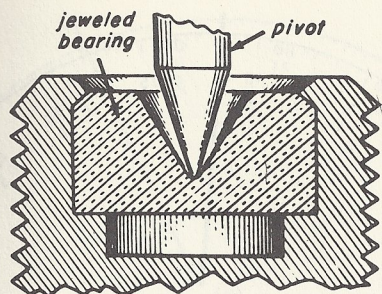


Fig. 7-2

delicate as a watch movement. The moving part (the pointer or needle) is attached to a small coil of wire that rides on sapphire-jeweled pivot bearings, as shown in Fig. 7-2. As in a watch, the movement has hair springs and is carefully balanced. Rough handling can cause a chipped jewel bearing, a distorted hair spring, or even force the pivots from the bearings. When a meter is dropped or handled roughly, a small particle of the pivot or jewel or of some other part may get between windings of the moving coil and cause the needle to be "sticky". See that the meter is not dropped and that it does not receive any shocks that can be avoided. A careful serviceman, when carrying a portable meter in his automobile, places it on the upholstered seat of his car in such a way that it cannot accidentally fall off if the car should go over an unexpected bump, or he provides a sponge-rubber lined case to hold the meter when traveling on service calls.

Whenever the meter is used to measure voltage, current, or resistance, some current flows through the moving coil. The wire used in winding the moving coil is very fine. If too much current is permitted to pass through it, either the coil or one of the hair springs connected to it may burn out. If the hair spring or coil does not burn out, the excess current may cause the springs to heat enough to change the tension of the spring. When this happens, the meter loses accuracy. In any event, when too much current flows through the moving coil, the needle is liable to bang against the needle stop at the end of the scale or against the side of the meter case. This causes the needle to bend and makes the meter less accurate.

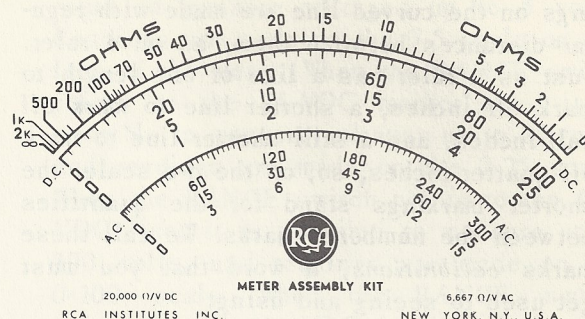


Fig. 7-3

7-2. METER SCALES

Examine Fig. 7-3, which shows the face of your multimeter. On the face, the scales are printed. According to the dictionary, a scale is a series of markings on a line used in measuring something. For example, a ruler has such markings made with regular distances between them so that feet, inches, and parts of inches may be measured off. A thermometer has a scale that measures degrees of temperature. The scales on your meter measure resistance in ohms, current in milliamperes, or electrical pressure in volts. The topmost scale is used when measuring resistance. Below the resistance scales are the scales for measuring voltage and current. When using a multimeter, it is important to know how to select the proper scale and know how to read it. In this lesson, you will examine each of these scales and see how each is used.

D-C Meter Scales. Figure 7-4 shows the scale used when measuring direct current or voltage. Other multimeters used by radio-men have similar scales. As you know from your study of Theory Lesson 5, direct current flows only in one direction. A source of such current is the battery. The d-c scales on your meter are used for measuring either current or voltage. If you examine Fig. 7-4, you will see that the mark-

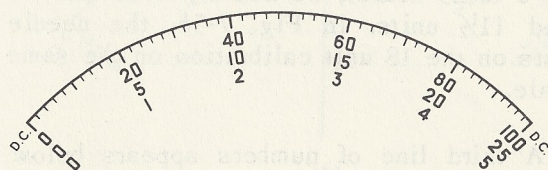


Fig. 7-4

ings on the curved line are made with regular distances between them, as on a ruler. Just as a ruler has a line of one length to mark off inches, a shorter line to mark off half-inches, and a still shorter line to mark off quarter-inches, so, on the d-c scale, the shorter markings stand for the quantities between the numbered marks. We call these marks *calibrations*, a word that you must get used to seeing and using.

Three sets of numbers are used with the d-c calibrations to make three d-c scales. The top line of numbers, below the calibrations, marks off the d-c scale, in intervals of 20, from 0 to 100. Each of these intervals is divided again. For example, the distance between 0 and 20 is divided into 10 units. Halfway between 0 and 20 is a line that stands for $\frac{1}{2}$ of 20, or 10 units. In the same way, halfway between 20 and 40 is the 30-unit point, and halfway between 40 and 60 is the 50-unit point; 70 is halfway between 60 and 80, and 90 is halfway between 80 and 100. The short calibrations between these points stand for two units each; the first four calibrations right after 0 are 2, 4, 6, and 8, and, at the other end of the scale, the four short calibrations between 90 and 100 are (reading from left to right) 92, 94, 96, and 98.

The second set of numbers just below 0 to 100 numbers, can be used to give the scale a value of from 0 to 25. The distance between 0 and 25 is divided into intervals of 5; so, reading across from left to right, you see the numbers 0, 5, 10, 15, 20, and 25. Each of these intervals of 5 includes 10 of the very short calibrations. Therefore, each of the short calibrations stand for $\frac{1}{2}$ unit, and two of these short calibrations stand for 1 unit. For example, in Fig. 7-5a the pointer rests on the third very short calibration to the right of the 10 calibration point. Because each of these short lines represents $\frac{1}{2}$ (on the 0 to 25 scale), we add $1\frac{1}{2}$ to 10 and we read $11\frac{1}{2}$ units. In Fig. 7-5b, the needle rests on the 18 unit calibration on the same scale.

A third line of numbers appears below the d-c calibrations and provides a 0-5 scale. This scale is marked off in inter-

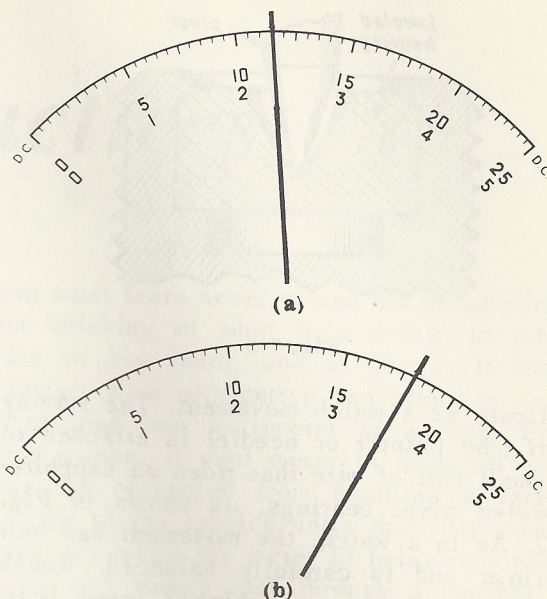


Fig. 7-5

vals of 1. Reading from left to right, you see the numbers 0, 1, 2, 3, 4, and 5. Each of these intervals is divided by 10 short calibrations. Therefore, each short calibration line represents $\frac{1}{10}$ of a unit. So, the position of the needle in Fig. 7-5a indicates 2.3 units on the 0-5 scale, and the position of the needle in Fig. 7-5b indicates 3.6 units.

In using this meter or any meter, you will find that the meter pointer sometimes rests between one calibration and the next. Just as when you measure with a ruler, things do not always exactly measure up to the inch- or half-inch line; so you must decide how close to the line they come. It is sometimes necessary to use your judgment to say what part of the distance between the calibrations is indicated by the meter needle. For example, in Fig. 7-6a the pointer is halfway between the 12th and 13th short calibrations on the 0-to-100 scale. The difference between each calibration is two units; half the distance represents one unit. So, the reading for this position of the pointer is 25 units. However, the same needle position on the 0-to-25 scale indicates only $6\frac{1}{4}$ units, while, on the 0-to-5 scale, it indicates 1.25 units. In Fig. 7-6b, using the 0-to-100 scale, the pointer rests between the 27th and 28th short calibrations and so indicates 55 units on the 0 to 100 scale. The same position

Meter Scales

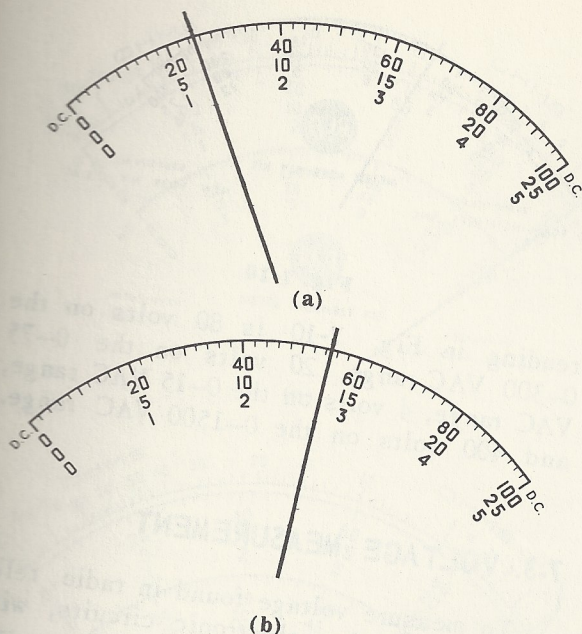


Fig. 7-6

of the needle represents $13\frac{3}{4}$ units on the 0-to-25 scale and 2.75 on the 0-5 scale.

You can get a better idea of how to use these scales by seeing how they are used in reading voltage or current. Let us consider voltage readings. If you examine the marker lines of the RANGE switch on your meter, as shown in Fig. 7-7, you will see that four d-c voltage ranges are provided. Starting at the top and working counter-clockwise (opposite to the direction of clock-hand movement), you will find 500-volt, 100-volt, 25-volt, and 5-volt d-c ranges. Note, too, that there are four a-c voltage ranges that share the same marker lines. We'll come back to these shortly.

Each position of the RANGE switch makes possible a different range of readings. When the pointer of the RANGE switch points to the 5-VDC marker line, it is pos-

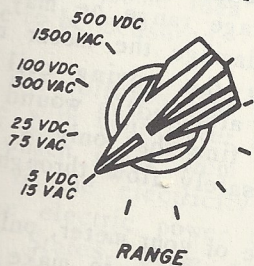


Fig. 7-7

sible to measure voltages up to 5 volts. Readings are made on the 0-5 scale on the face of the meter. When the RANGE switch points to the 25-VDC marker line, it is possible to measure voltages up to 25 volts, and readings are made on the 0-25 scale. When the RANGE switch points to the 100-VDC line, it is possible to measure up to 100 volts, and readings are made on the 0-100 scale. When the RANGE switch points to the 500-VDC reading, it is possible to measure up to 500 volts. Readings are made on the 0-5 scale, the same scale that was used to read up to 5 volts, but readings on the scale should now be multiplied by 100. For instance, if the meter pointer rests on the 5 calibration, the reading is 500 volts; if the meter rests on the 2 calibration, the reading is 200 volts.

The value of the small calibrations is also multiplied by 100. So each small calibration, which stood for $1/10$ volt on the 5-VDC scale, now represents 10 volts.

In Fig. 7-8a, the pointer rests on the 1 calibration. If we are using the 5-VDC range, the reading is 1 volt. If we are using the 500-VDC range, the reading is 100 volts.

In Fig. 7-8b, the pointer rests on the calibration between 2 and 3. On the 5-VDC scale, the reading is 2.5 volts. On the 500-VDC scale, the reading is 250 volts.

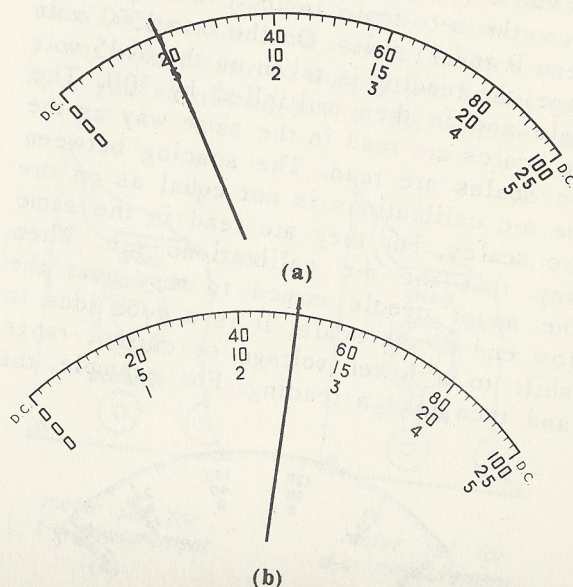


Fig. 7-8

A-C Voltage Scales. Your multimeter also measures a.c. A-c voltages are used in many ways. In Theory Lesson 1, you learned that high-frequency electrical waves are used in radio broadcasting. Actually, alternating voltages of very high frequency are used. Other alternating voltages and currents of very low frequencies are used every day to provide electricity for homes and factories, street lighting, trolley cars, and other electrical equipment. Most of the electrical power produced in this country is 60-cycle a.c. However, there are some places in the United States where 25-, 40-, or 50-cycle a.c. is still produced.

Most multimeters have separate d-c and a-c scales. Directions are supplied with such meters to explain which scales are used for the current and voltage ranges. The a-c scales of your multimeter, shown in Fig. 7-9, are marked off in red on the meter dial. The RANGE switch on your meter has a-c range markings at each position just below the d-c range markings. When measuring a-c voltages, use these a-c markings to position your RANGE switch; disregard the d-c markings.

The first line of numbers below the a-c calibrations on the face of the meter presents values of voltage from 0-300 volts. The next line of numbers below the a-c calibrations indicates values of voltage from 0 to 75 volts. The numbers in the third line below the a-c scale indicate voltages between 0 and 15 volts. On the 0 to 1500 volt range, the reading is taken on the 0-15 volt scale and is then multiplied by 100. The a-c scales are read in the same way as the d-c scales are read. The spacing between the a-c calibrations is not equal as on the d-c scales, but they are read in the same way that the d-c calibrations are. When the meter needle comes to rest near the low end of the scale, it is a good idea to shift to a lower voltage or current range and then take a reading. For example, the

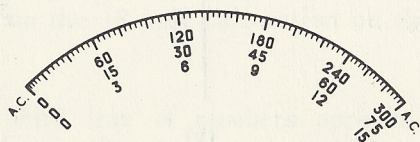


Fig. 7-9

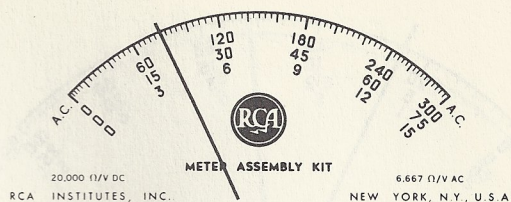


Fig. 7-10

reading in Fig. 7-10 is 80 volts on the 0-300 VAC range, 20 volts on the 0-75 VAC range, 4 volts on the 0-15 VAC range, and 400 volts on the 0-1500 VAC range.

7.3. VOLTAGE MEASUREMENT

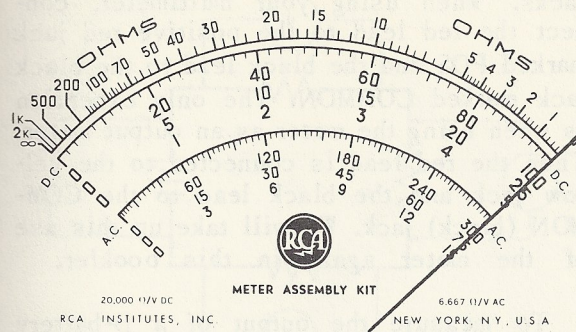
To measure voltage found in radio, television, and other electronic circuits, with any voltmeter, we should first know two things:

1. The kind of voltage: a.c. or d.c.
2. Approximately how much voltage is to be measured.

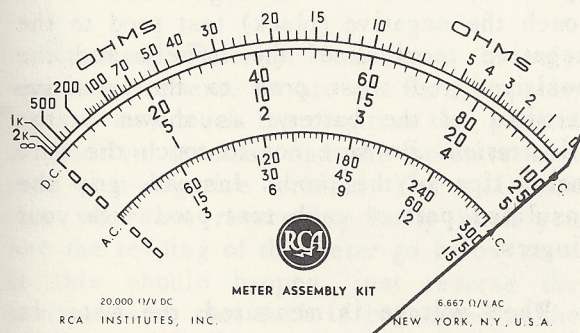
We should know the kind of voltage because most d-c voltmeters cannot measure a-c. The direction of a-c changes so often in a second that the meter needle cannot keep up with the changes and so stays in one position. When a d-c voltmeter is used to measure a-c, you may see the needle vibrating near the zero position if you look very closely. When a serviceman measures voltage in a piece of electronic equipment, he knows the kind of voltage he expects to find. He knows whether to use an a-c voltmeter or a d-c voltmeter, or, if he has a multimeter, whether to put the FUNCTION switch in the a-c position or the d-c position.

He should know how much voltage he is going to measure because if he uses the wrong voltage range he may burn out or otherwise damage the meter movement. Remember that the moving coil to which the pointer is attached is wound with very fine wire, so fine that only a very small current may safely flow through the coil.

In the case of your meter, only 50 microamperes is necessary to make the needle go to full scale, as shown in Fig. 7-11a. Each voltage and current range in the meter



(a)



(b)

Fig. 7-11

is designed so that only 50 microamperes of current, at the most, flows through the meter coil when the current or voltage being measured DOES NOT EXCEED the voltage or current shown by the position of the RANGE switch. For example, if we try to measure 100 volts with the RANGE switch on the 5-volt position, twenty times the rated current (1,000 microamperes) flows through the coil. This causes the meter needle to bang against the side of the case, as shown in Fig. 7-11b. This bends the needle out of shape and may possibly burn out the coil, damage the hair springs, or otherwise hurt the meter movement. So, you can see it is very important to have some idea of the amount of voltage to be measured.

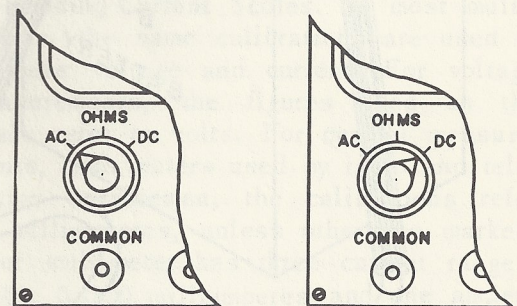
Among the voltages that you are likely to measure with your meter are power-line voltages, which range from about 110 to 120 volts in the electricity supplied by most of the electric power companies in the United States. Some special power lines, usually found in factories and other business places, may be 220 to 240 volts or higher, and certain home and farm power

supplies provide as low as 30 volts output. In radio receivers, d-c voltages sometimes exceed 300 volts; they practically never go beyond 500 volts. A-c voltages as high as 600 or 700 volts are found in radio receivers equipped with power transformers. On the other hand, television receivers have special power supplies that provide voltage of from 3,000 to 30,000 volts. For that reason, no serviceman touches his meter to a television receiver without having the service information, including information on voltages, from the television receiver manufacturer, or without being fully instructed in what measurements to make and how to make them.

When completed, your multimeter will be capable of measuring most of the voltages found in radio, television, and other electronic circuits. However to protect yourself and your meter, make no measurements without first taking three precautions:

1. See that the FUNCTION switch is set for the kind of measurement you are going to make. For example, the FUNCTION switch must point to AC if you are going to measure a.c., or to DC if you are going to measure d.c., as shown in Fig. 7-12 a and b.

2. See that the RANGE switch is set at the proper range for the amount of voltage to be measured. For example, when you measure filament voltages in a radio receiver that uses tubes that have 6-volt heaters and a power transformer to supply the heater voltage, you should know that the voltage must

meter set for
a-c measurement

(a)

meter set for
d-c measurement

(b)

Fig. 7-12

be around six volts, so you place the RANGE switch on the 0-15 VAC range. You should know that you are measuring a.c.; so you turn the FUNCTION switch to AC. However, if you are going to measure the output of the d-c power supply, which should be somewhere around 250 volts, you should place the RANGE switch on the 500 VDC position and turn the FUNCTION switch to DC. If you have no idea of how much voltage is to be measured, the best way to start is to try the highest range first. Then try the next range below, then the next, and so on.

3. Where very high voltages are expected, as in television equipment, make sure the test prods and leads are designed for measuring high voltages. If they are not, it is possible to get a shock or burn from the voltage that "leaks" through the insulation. In measuring high voltages, only high-voltage wire special protected test prods should be used.

To measure voltage properly, the test leads must be connected to the proper

jacks. When using your multimeter, connect the red lead to the positive red jack marked POS and the black lead to the black jack marked COMMON. The only exception is when using the meter as an output meter. Then the red lead is connected to the yellow jack and the black lead to the COMMON (black) jack. We will take up this use of the meter again in this booklet.

To measure the output of a B-battery rated at $22\frac{1}{2}$ volts, set the FUNCTION switch to DC and the RANGE switch to 25 VDC, as shown in Fig. 7-13a. Then touch the negative (black) test prod to the negative terminal of the battery and the positive (red) test prod to the positive terminal of the battery, as shown in the illustration. Be sure not to touch the bare metal tips of the prods. Instead, grip the insulated part of each test prod with your fingers.

When voltage is measured, the meter is always connected across (in shunt with) the terminals of the voltage source or between any two points where a difference in voltage exists. Figure 7-14 shows examples of measuring voltage.

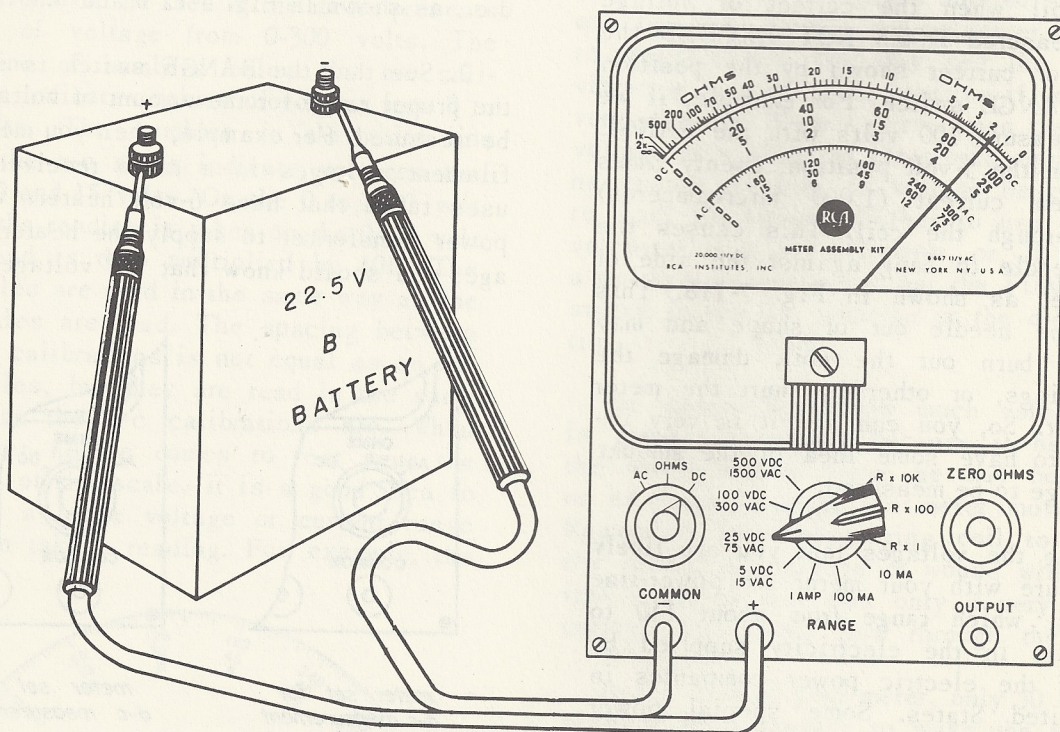


Fig. 7-13

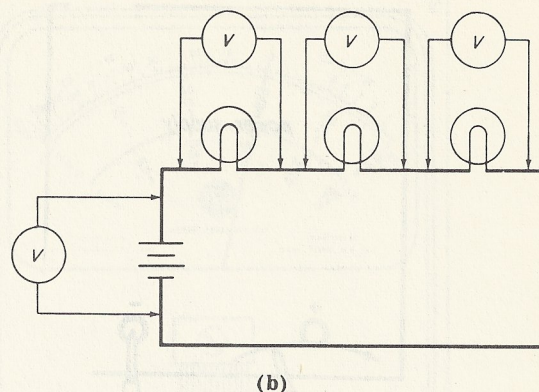
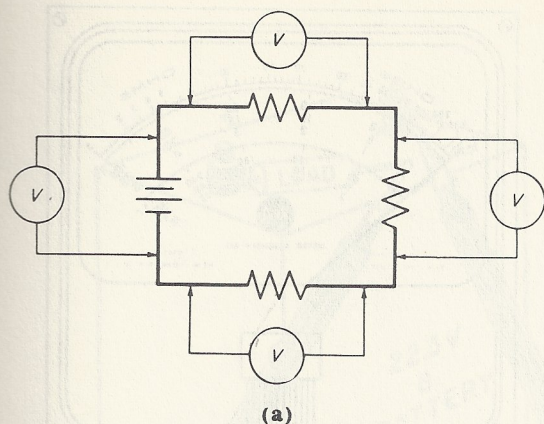


Fig. 7-14

Reversed Polarity. Sometimes, in voltage measurement, we are not sure of polarity and may touch the negative test prod to a positive terminal and the positive test prod to a negative terminal. You will know that you have reversed polarity when you see the reading of the meter go below zero. If this should happen, just reverse the test prods so that each is connected to the proper polarity. No damage will occur to the meter by reversing polarity if the proper voltage range is being used.

Measuring Unknown Voltages. When measuring a voltage whose approximate amount is unknown, *use the highest range first.* Touch one of the test prods to one terminal of the circuit being tested. Watching the meter needle, lightly brush the second terminal of the circuit with the remaining test prod, as shown in Fig. 7-15. Actually, with this brushing stroke you will make a momentary connection and immediately disconnect with the same movement. If the meter needle moves rapidly toward the high end of the scale, it is not safe to measure the voltage with that meter range. If you are using the highest range during this test, then the meter, as it is, cannot be used to read the voltage. If, however, the meter needle starts to move slowly during this brushing contact, it is safe for you to place both test prods firmly on the terminals and read the voltage. If you use the 500-volt range to measure d.c. on your multimeter and the reading falls below 100 volts, move the RANGE switch to the 100-volt range. If the reading falls below 25 volts, use the 25-volt range. If, on the 25-volt range, the reading falls below 5

volts, use the 5-volt range. Usually, the best and most accurate voltage reading is made with the range that has a top reading very close to the voltage you are measuring.

7.4. CURRENT MEASUREMENT

So far, we have discussed only the measurement of voltage. It is also important to know how to measure current. Because of the way in which the meter is connected to the circuit in current measurements, it is much easier to damage the meter movement while making current measurements than in making voltage measurements. For this reason, many an experienced serviceman hesitates to make current measurements for fear of burning out his meter. However, by using good sense and taking care, current measurements may be made with your meter as readily as voltage measurements.

Reading Current Scales. In most multimeters, the same calibrations are used to measure voltage and current. For voltage measurements, the figures used on the scale refer to volts. For current measurements, with meters used by radio and television servicemen, the calibrations refer to milliamperes, unless otherwise marked. Your multimeter has three current ranges: 0–10, 0–100 milliamperes, and one ampere (1,000 milliamperes). These current ranges are for d.c. only. There is no a-c current range. Figure 7-16 shows how the meter is set up for measuring current on each of these ranges. All current ranges are read

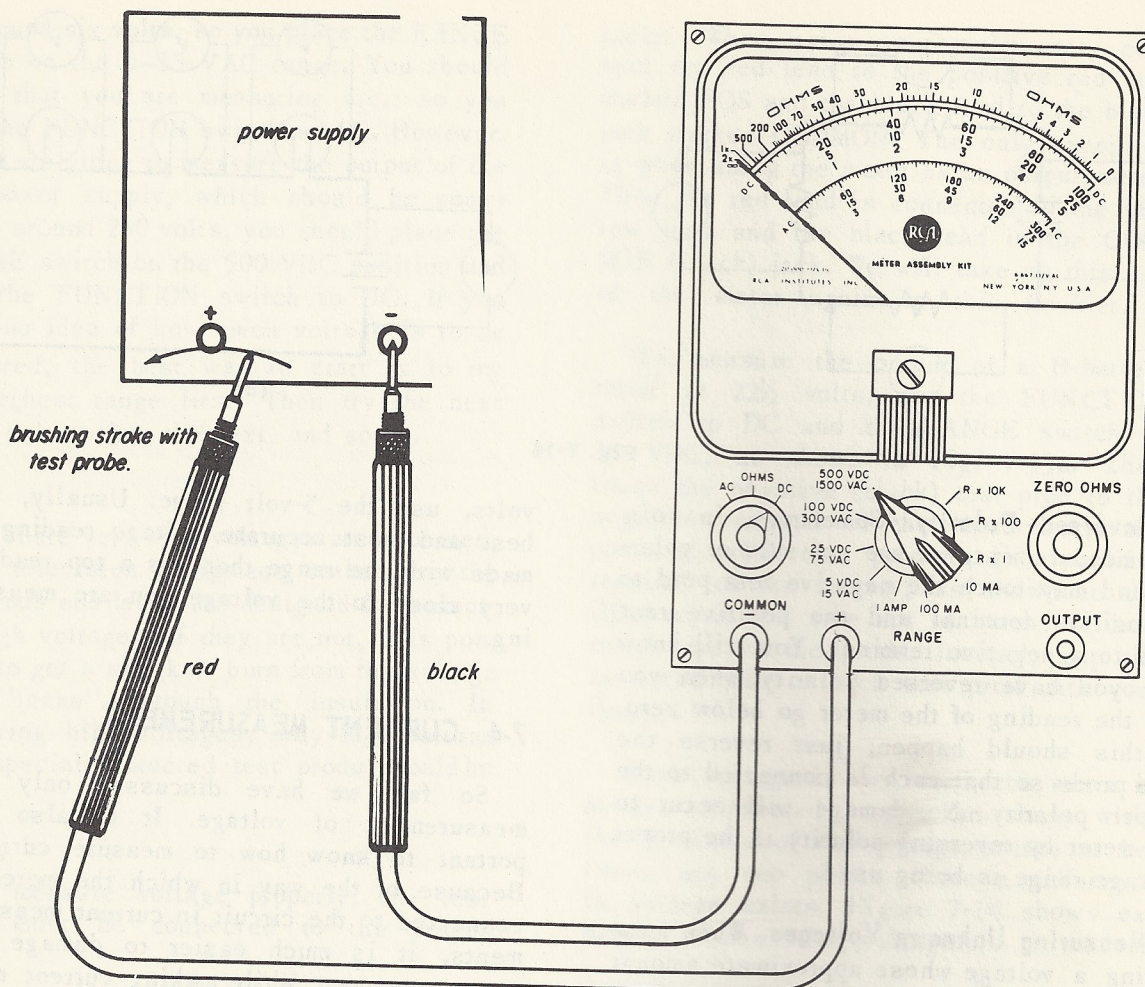


Fig. 7-15

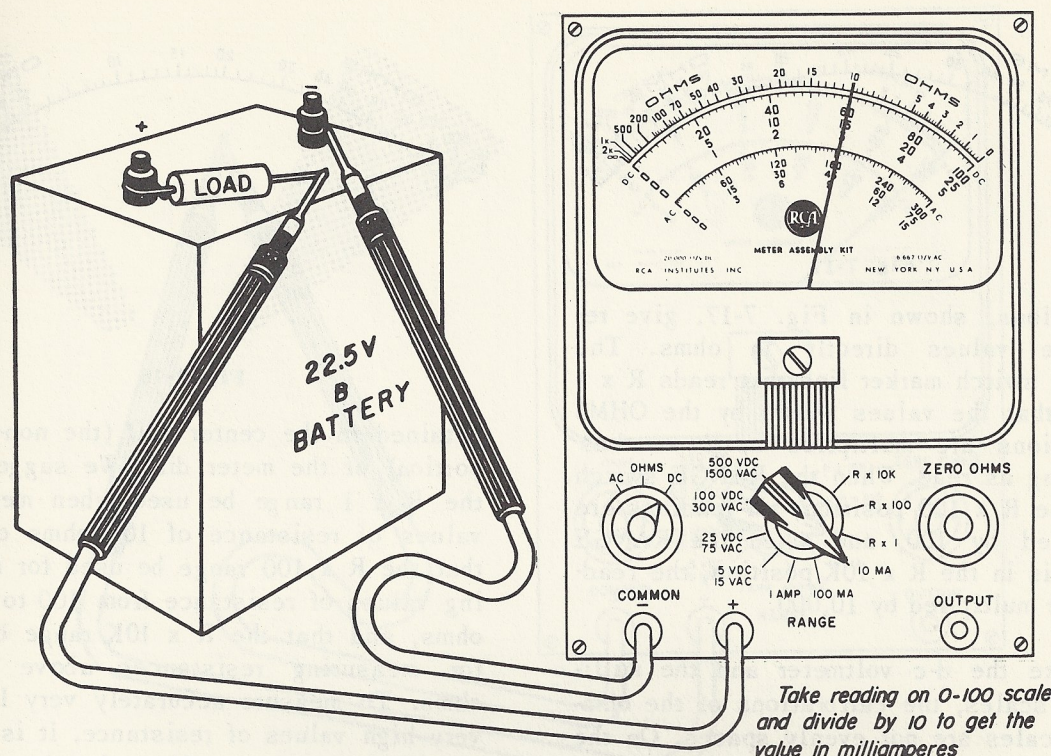
on the 0 to 100 d-c scale. Figure 7-16a shows a reading of 6 ma (on the 10-MA scale); Fig. 7-16b shows 60 ma (on the 100-MA scale); and Fig. 7-16c shows 0.6 amperes (600 milliamperes) on the 1 AMP scale.

Measuring Direct Current. Look again at Fig. 7-16a. Three pieces of apparatus are shown connected together: a battery, a resistor, and a millimeter. Together, they form a series circuit because there is one continuous circuit without any separate branches. The source of voltage is shown as a battery, but it might be a d-c generator, a d-c power outlet, a d-c power supply, or some other source of d-c. Note that the resistor is called a *load*. By load, we mean something that uses electrical power. Whenever measuring current, the meter is connected in series

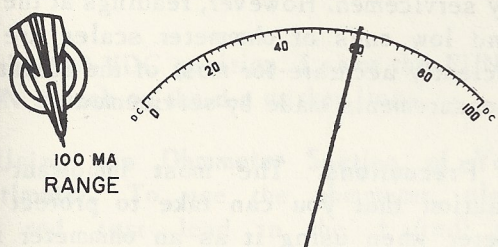
with the source of electricity and the load.

Caution: If you were to connect any of the current scales of your meter directly across a battery or other voltage source, you would instantly damage the meter movement.

Measuring Unknown Currents. It is necessary to take special care in measuring unknown currents. Start with the highest current scale first (the one-ampere current range in your multimeter). As in the case of the voltage reading, touch one prod firmly to one side of the circuit and, with a brushing stroke, make a temporary connection with the other prod to the other side of the circuit. Be sure not to touch the bare metal of the test prods. If the meter needle moves

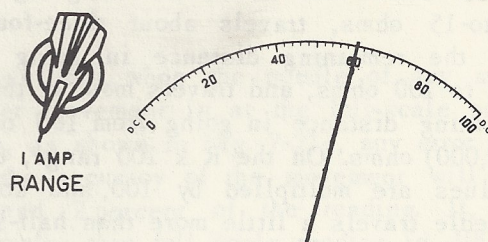


(a)



On 100-MA range, take reading on 0-100 scale.

(b)



On 1-amp range, take reading on 0-100 scale and multiply by 10 to get value in milliamperes

(c)

Fig. 7-16

very rapidly, the range is not high enough for measuring the current in the circuit. If the meter needle travels slowly, it is safe to make a firm connection to the circuit for a current reading. By noting the current reading, you can tell whether a lower milliampere range is safe to use. As was the case with the voltage readings, the current range that gives you a reading closest to the highest calibration on the scale is the most accurate.

7-5. RESISTANCE MEASUREMENT

In addition to measuring voltage and current, radio and television servicemen

need to measure the resistance of circuits and circuit parts. For such measurements, they use an ohmmeter. In later lessons on troubleshooting and circuit checking, you will find that the ohmmeter is a very useful instrument in the hands of a man who understands the principles of electrical and radio circuits.

Reading Ohmmeter Scales. Your multi-meter has three ohmmeter ranges, all of which use the same scale. When the FUNCTION switch is on OHMS, and the RANGE switch is on $R \times 1$, $R \times 100$, or $R \times 10K$, the meter is set to measure ohms. When the RANGE switch is set to $R \times 1$, the

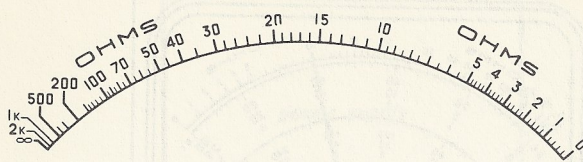


Fig. 7-17

calibrations, shown in Fig. 7-17, give resistance values directly in ohms. The RANGE switch marker line that reads $R \times 1$ means that the values shown by the OHMS calibrations are multiplied by 1 — thus remaining as read. When the RANGE switch is in the $R \times 100$ position, all readings are multiplied by 100, and when the RANGE switch is in the $R \times 10K$ position, the readings are multiplied by 10,000.

Unlike the d-c voltmeter and the milli-ampere scales, the calibrations of the ohmmeter scales are not evenly spaced. On the $R \times 1$ range, the meter needle travels a little more than half-scale in going from 0-to-15 ohms, travels about three-fourths of the remaining distance in going from 15 to 100 ohms, and travels most of the remaining distance in going from 100 to 2k (2,000) ohms. On the $R \times 100$ range, these values are multiplied by 100, and so the needle travels a little more than half-scale in going from 0-1500 ohms, and most of the remaining distance in going from 1,500 ohms to 200k (200,000) ohms. In the $R \times 10K$ range, the needle travels half-scale in going from 0 to 150,000 ohms, and in most of the remaining half-scale it goes from 150,000 ohms to 20 megohms. You will note that the slightest movement of the meter needle at the high end of any of the ohmmeter scales represents a large change in ohms. In fact, on the $R \times 10K$ range, the distance between the 1 megohm and 10 megohm calibrations is very small. So, an accurate reading at that end of the scale is practically impossible. This is true for ohmmeter scales found on all standard radio and television test meters. For that reason, the makers of test meters suggest that, in using an ohmmeter, you use the range which gives you a reading as close to the center of the scale as possible. As shown in Fig. 7-18, the most accurate ohmmeter readings are

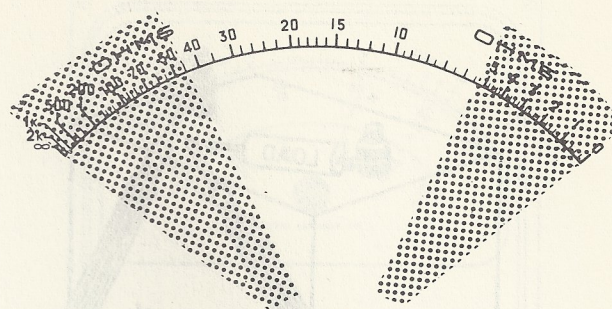


Fig. 7-18

obtained in the center half (the non-shaded portion) of the meter dial. We suggest that the $R \times 1$ range be used when measuring values of resistance of 100 ohms or less, that the $R \times 100$ range be used for measuring values of resistance from 100 to 10,000 ohms, and that the $R \times 10K$ range be used for measuring resistances above 10,000 ohms. To measure accurately very low and very high values of resistance, it is necessary to use more complicated and expensive equipment than the usual ohmmeter used by servicemen. However, readings at the high and low ends of ohmmeter scales are sufficiently accurate for most of the resistance measurements made by servicemen.

Precautions. The most important precaution that you can take to protect your meter when using it as an ohmmeter is to be sure that the resistor, coil, or other part being tested is not connected in any way to a source of voltage. This means that line cords must be disconnected from electric outlets of power operated equipment, or that batteries must be disconnected from all battery operated equipment, before your ohmmeter test prods touch a part under test. All ohmmeters use some source of electricity, which may be either a battery or a power supply connected to an electric outlet. Your meter uses a 1.5-volt cell on the first two ranges and a 6-volt battery on the $R \times 10K$ range. When the meter is not actually being used to measure resistance, the RANGE switch should be turned from all of the ohmmeter ranges. This is so that you will not accidentally use the ohmmeter to measure voltages or current. Actually, when the meter is not in use, the best place to leave the RANGE switch is

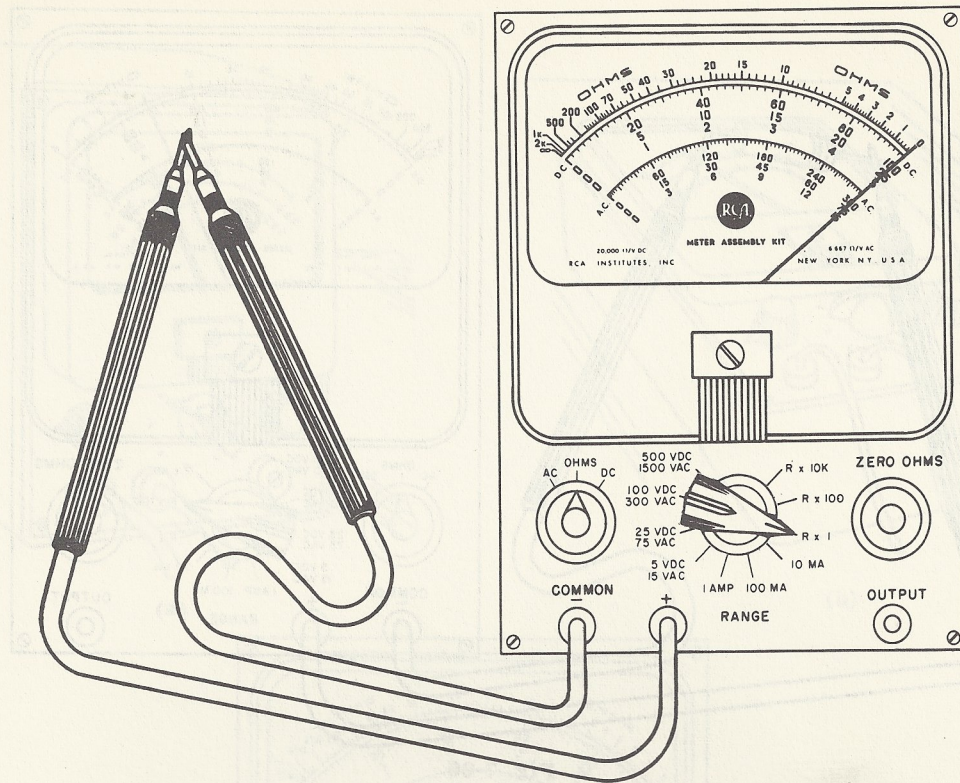


Fig. 7-19

on the 500-VDC position. Leave the FUNCTION switch on the d-c marker lines.

Using the Ohmmeter Section of Your Multimeter. To use the ohmmeter, place the red test lead in the + (red) pin jack and the black test lead in the COM pin jack. Turn the FUNCTION switch to OHMS and the RANGE switch to the desired range. Next "zero" the meter by adjusting the potentiometer marked ZERO OHMS. The adjustment is made by shorting the test prods together, as shown in Fig. 7-19 and adjusting the zero ohms knob until the meter needle rests directly over the zero calibration line. Then place the test leads across the part to be measured as shown in Fig. 7-20, and read the proper resistance scale.

7-6. METER ACCURACY

The accuracy of the meter movement used in your multimeter and of most of the meter movements used in test equipment for servicemen, is ± 2 -percent at full scale. This

means that when the needle of any such meter movement is at the full-scale position, as shown in Fig. 7-21a, any error due to the accuracy of the movement will not exceed 2 percent of the reading. If, for example, this full scale reading is 100 on the 100-volt range, the error due to the accuracy of the movement is no more than 2 volts (2 percent of 100). This means, however, that *any reading* obtained on the 100 volt range *may be wrong by as much as 2 volts*. So, a 10-volt reading on the 100-volt range, as shown in Fig. 7-21b, may represent a voltage as low as 8 volts and as high as 12 volts. Therefore, the amount of error due to the movement may be as much as 20% of the 10-volt reading. For this reason, you have been urged to use voltage and current ranges that will give you readings as near to full scale as possible, because the nearer to full scale, the greater is the percentage of accuracy.

Another factor that affects the accuracy of meter readings is the accuracy of the resistors used in the voltage and current ranges. Naturally, resistors of ± 1 percent accuracy give more

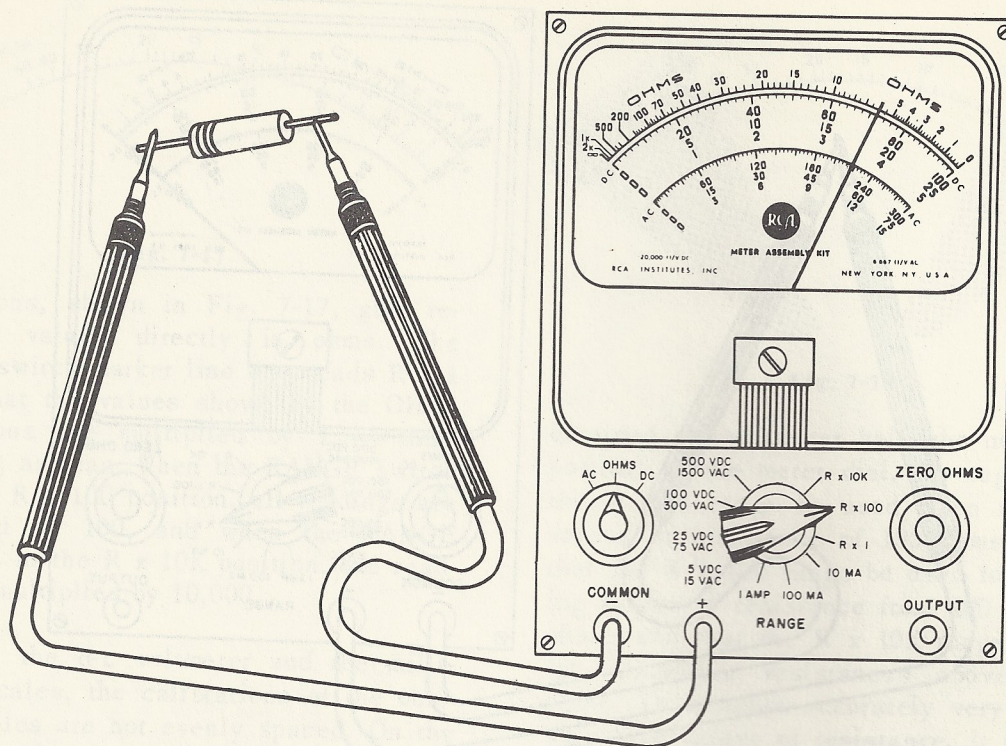


Fig. 7-20

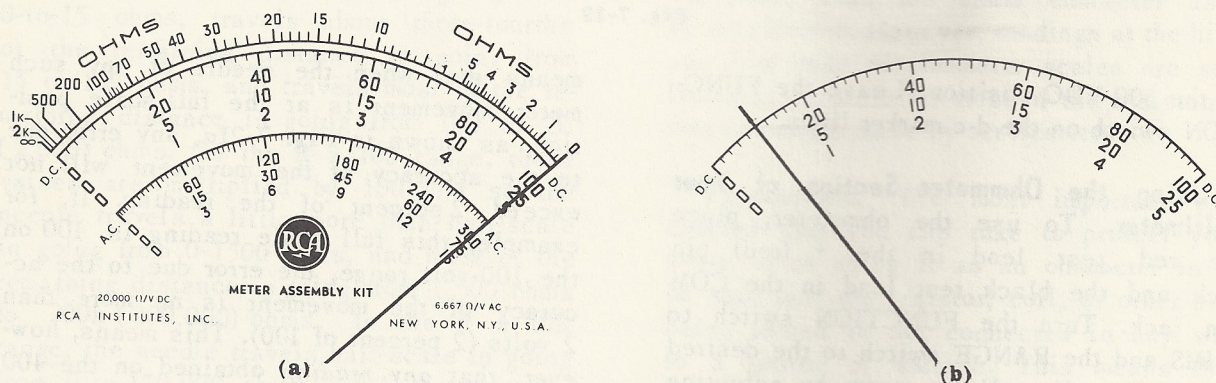


Fig. 7-21

accurate readings than resistors of higher tolerance.

Another factor that affects meter accuracy is the position of the meter — whether it is standing upright or laying flat on the bench, as in Fig. 7-22a and b. If the meter needle does not return exactly to zero in either of these positions, it may be adjusted to zero position by turning the screw shown in Fig. 7-22c, with a small screwdriver.

Other factors that affect the accuracy of meter readings are taken up in Service Practices 8. In that booklet, meter sensitivity is also discussed. Be sure to read it

carefully so that you may better understand your meter.

7.7. PRECAUTIONS TO REMEMBER

Since your meter is so important a help in your work as a serviceman, you will want to use it carefully and accurately. As you studied this lesson, you learned certain precautions to take so that you do not damage your meter. Some of the important things to remember are listed below.

1. Never try to measure voltage on the

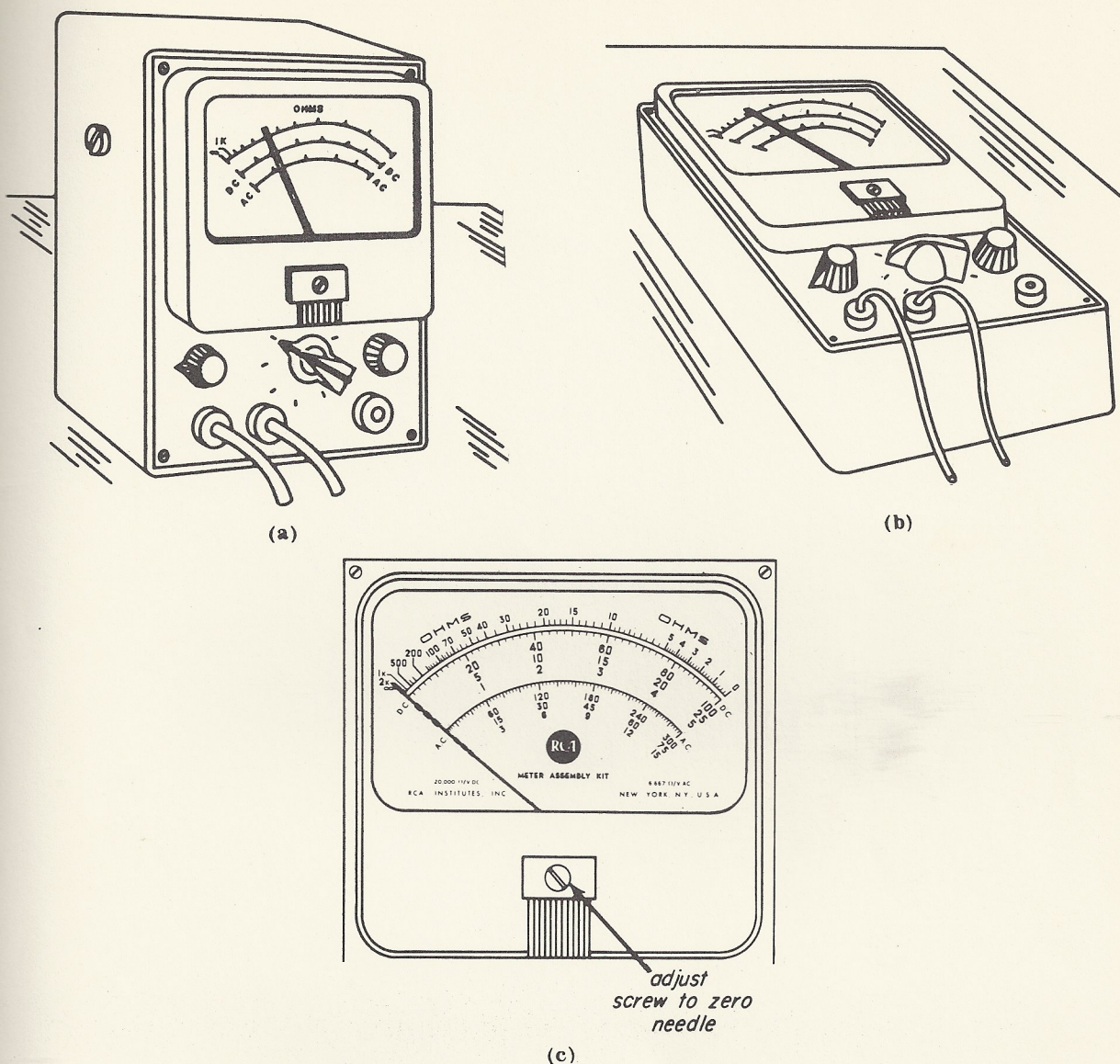


Fig. 7-22

voltmeter section of your multimeter without knowing about how much voltage you are going to measure. If you use the wrong range, you may damage or burn out your meter movement. If you are not sure of the voltage, use the highest range first.

2. When measuring an unknown current, use the highest range first.

3. Never connect any of the *current* scales of your meter *across* a battery. If you do, you will damage the meter movement.

4. When measuring resistance with your

meter, be sure that the electrical part that you are measuring is not connected to a source of voltage.

5. When switching from one function to another (or from one range to another) be sure that the test leads are not connected to any part that is connected to a source of voltage.

6. When you are not using your multimeter, keep the FUNCTION switch in the DC position and the RANGE switch in the 500 VDC position. In this position, you provide the greatest protection for your meter.